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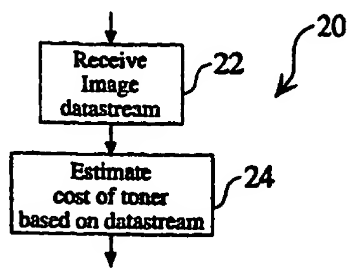
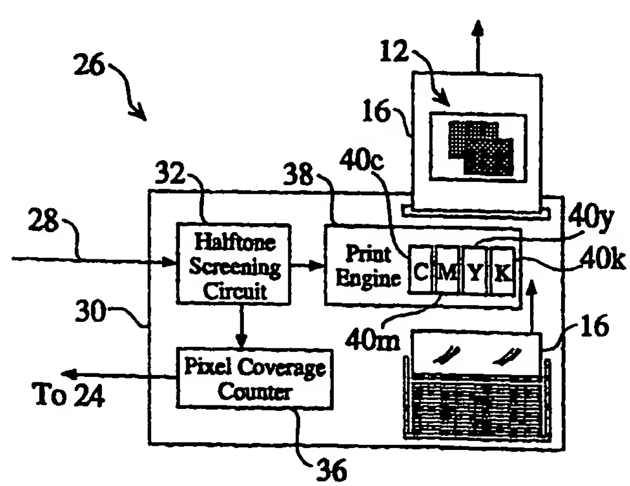
(54) Title: TONER USAGE ESTIMATION SYSTEM

(57) Abstract

A toner usage estimation system is provided, in which an image file is analyzed to determine the relative usage of one or more toners used to define an image on a substrate. The image file is analyzed as a basis for estimating the cost of processing a particular print job. In one embodiment, a pixel coverage counter is added in the hardware path of a printer to count pixel coverage mapping, which allows the consumable usage of toner to be determined. In another embodiment, a software approximation on the coverage of toner is determined, based on the use of a reduced resolution thumbnail of an image.





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TONER USAGE ESTIMATION SYSTEM

FIELD OF THE INVENTION

The invention relates to the field of printer cost estimation systems. More particularly, the invention relates to a toner usage estimation system to determine the cost of consumable materials for printed documents.

BACKGROUND OF THE INVENTION

Printer manufacturers generally estimate printed page cost based on a rough estimate of 5% toner coverage across a page. While this estimate can provide a comparison of the relative cost of printing an image between different printers, the actual toner page coverage between different printed pages can vary significantly from printer manufacturer's estimates. Therefore, the actual cost per printed page can vary significantly for different print jobs.

The number of toners used in print engines typically varies from one toner (monochrome printing) to four toners (cyan, magenta, yellow, and black)(commonly referred to as CMYK). Some specialized printing processes may use more than four toners, such as an enhanced four color CMYK process that includes the additional application of one or more spot colors.

The cost of consumables in printing processes can be significant, particularly for many color printers that use advanced toners or application techniques, such as for ink jet, thermal wax transfer or dye-sublimation printers.

An exact toner bit map of a page image is generally never held in any memory. With current analog screening techniques, a contone (CMYK)(color) or K (monochrome) image bit map is submitted, as a data stream, to a halftone screening circuit within a printer controller. The printer controller then generates commands to release toner upon a substrate to produce a printed image, based upon the bit map of the page image. The toner is deposited onto the substrate, in a proportion relative to the specified percentage of C, M, Y and K present in the data stream.

M. Farrell, *Method of Estimating Cost of Printing Materials Used to Print a Job on a Printing Apparatus,* U.S. Patent No. 5,383,129 (17 January 1995) discloses a method of estimating the cost of printing materials used to print a job on a printing apparatus, which includes the steps of storing billing rates reflecting the cost of printing materials to be used in printing the job, selecting a first quantity of printing materials to be used in printing the job, and prior to printing the job, calculating as a function of the

first selected quantity of printing materials and one of the stored billing rates, a first printing materials cost of the job. While Farrell discloses print cost estimation methods based on a number of stored billing rates and materials costs, he fails to disclose a system for estimating the cost of toner for each job based upon the image file bit map.

Some computer and printer systems provide reduced resolution (thumbnail) images of ripped jobs as previews of images to be printed. While thumbnail images are extremely condensed bit map files of original image files, they provide a reasonably accurate compressed representation of image files.

It would be advantageous to provide a method and apparatus to estimate toner usage for print jobs based on the image data from each job. It would also be advantageous to provide a method to estimate toner usage for print jobs based on thumbnail image bit maps.

While the disclosed prior art system and methodology provides a basic printing cost estimation system, it fails to provide a toner usage estimation system that bases estimations on the image or document files to be printed. The development of such a toner usage estimation system would constitute a major technological advance.

SUMMARY OF THE INVENTION

A toner usage estimation system is provided, in which an image file is analyzed to determine the relative usage of one or more toners used to define an image on a substrate. The image file is analyzed as a basis for estimating the cost of processing a particular print job. In one embodiment, a pixel coverage counter is added in the hardware path of a printer to count pixel coverage mapping, which allows the consumable usage of toner to be determined. In another embodiment, a software approximation on the coverage of toner is determined, based on the use of a reduced resolution thumbnail of an image.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows relative pixel toner percentage use between adjacent pixels within an image on a substrate;

Figure 2 shows a process color pixel comprising a plurality of contone color pixels;

Figure 3 shows a process color pixel comprising a plurality of contone color pixels, wherein each of the contone color pixels has a specified percentage of applied toner coverage;

Figure 4 is a flowchart of a basic toner usage estimation process;

Figure 5 is a block diagram of one embodiment of the toner usage estimation system configured within a printer;

Figure 6 shows the production of a low resolution image from a full resolution image, resulting in a reduction in file size;

Figure 7 shows the relative reduction in the size of a portion of a file, from a high resolution 8 by 8 pixel block to a low resolution single pixel block;

Figure 8 is a flowchart of a toner usage estimation process that uses a reduced resolution bit map of an image;

Figure 9 is a block diagram of the toner usage estimation system configured between a client server, a printer controller and a printer;

Figure 10 is a block diagram of another embodiment of the toner usage estimation system configured between a plurality of customer computers, a client server, and a plurality of printer controllers and printers; and

Figure 11 is a block diagram of an alternate embodiment of the toner usage estimation system wherein a toner usage estimation processor is located between a plurality of department servers and a plurality of printer controllers and printers.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 shows the relative pixel toner percentage use 10 between adjacent pixels 14 within an image 12 on a substrate 16. The amount of toner used to define an image 12 typically varies from zero to 100 percent of the size of a pixel 14. For a monochrome image 12, a single toner cartridge 40 (FIG. 5) is used to define an image 12 on a substrate 16.

Figure 2 shows a process color pixel 14 comprising a plurality of contone color pixels 14C, 14M, 14Y and 14K. Each process color pixel 14 in a printed image 12 is a combination of the controlled application of one or more toners 40. The offset and stacking order of the color pixels 14C, 14M, 14Y and 14K, as well as the halftone pattern defined between pixels 14 across a substrate 16 is usually defined by the printer 30, 90 used (FIGS. 5, 9-11). Some halftone features are sometimes specified by the user. Figure 3 shows a process color pixel 14 comprising a plurality of contone color pixels 14C, 14M, 14Y and 14K, wherein each of the contone color pixels 14 has a specified percentage of applied toner coverage. In the color pixel 14 shown, there is a large applied percentage of magenta (M) 40m and yellow (Y) 40y toner, and a low applied percentage of cyan (C) 40c and black (K) 40k toner.

Figure 4 is a flowchart of a basic toner usage estimation process 20, wherein a image datastream is first received 22. Based on the image datastream, the datastream is analyzed to count the specified toner density of each pixel 14 within an image to be printed 12, and the cost of toner is estimated 24 based on the image datastream.

The toner usage estimation process uses image data to determine the cost of printing an image 12 on a substrate 16, based on a calculated estimate of toner use for a given image 12. The estimated cost can be used for accounting and job estimation purposes, either internally to a business, or externally, such as for billing purposes by a print shop to a customer. Printed pages 16 that use more toner 40 (40c, 40m, 406, 40k), particularly more color toner 40c, 40m, and 40y, typically cost more to print than pages that use less toner. By providing an estimate of the use of toner 40 to produce a printed page 16, the toner usage estimation process 20 can be used to charge customers or departments, based on estimated job costs.

Figure 5 is a block diagram 26 of one embodiment of the toner usage estimation system 20 configured within a printer 30. An incoming image datastream signal 28 is processed by a halftone screening circuit 32, which forwards the halftone information to a print engine 38. The print engine 38 selectively applies one or more toners 40 to define a printed image 12 on a substrate 16. To estimate toner usage, a pixel coverage counter 36 receives 22 the image datastream, and forwards the mapping information, so that the datastream is analyzed to count the specified toner density of each pixel 14 within an image to be printed 12, and the cost of toner for the printed image 12 is determined. The pixel coverage counter may be, for example, an estimator that counts contone percentages before halftoning (shown in Fig. 5) or it may be an exact counter that counts pixel coverage after halftoning.

A continuous tone (contone) image bit map 46 typically uses 8 bits per plane of memory, which is not exactly what the printer 30 lays down on a printed page 16. The printer 30 applies toner to a page 16 based on an identified or processed halftone bit map. There are different halftone formats, such as dithering or screens, and are achieved either by hardware or software. Most printer engines 38 produce an analog screen halftone in hardware. The actual screening is calculated and used by the printer 30 to control the application of toner 40 within a print engine 38.

Toner Usage Estimation Using Thumbnails. Figure 6 shows the production of a low resolution image 50 from a full resolution image 46, resulting in a reduction in file size. Figure 7 shows the relative reduction 52 in the size of a portion of a file 46, from a high resolution 8 by 8 pixel block 54 to a low resolution single pixel block 58.

A typical 400 dpi 8 1/2" by 11" full color image requires 64 MB of storage. A reduced resolution image 50 (referred to as a thumbnail) typically takes up a small fraction of the required memory of the original file 46. Therefore, toner usage estimation based on a reduced resolution image 50 takes considerably less processing time. As well, thumbnail images 50 are typically provided by printer controllers 86, as preview images to a client server 72 (FIG. 9). Thumbnail images 50 are thus easily applied for toner usage estimation and accounting purposes.

Figure 8 is a flowchart of a toner usage estimation process 60 that uses a reduced resolution bit map 50 of an image. The toner usage estimation process 60 comprises the following steps:

i) receiving 62 a reduced resolution bit map 50 of an image 74 residing in a first image color space;

ii) translating 64 the reduced resolution preview bit map 50 to a second image color space; and

iii) estimating 66 the use of one or more toners 40c, 40m, 40y, and 40k to define the printed image 12 on a substrate 16 based upon the translated reduced resolution bit map 50.

The toner usage estimation process 60 that uses a reduced resolution bit map 50 is typically faster than a process that counts each and every pixel 14 within the datastream of a full resolution image 46. While the accuracy of the toner usage estimation process 60 is generally not as precise as toner usage estimation processes that use full resolution images 46, the estimation is adequate for most applications.

Figure 9 is a block diagram of a toner usage estimation system 70 configured between a client server 72, a printer controller 86, and a printer 90. A file image 74 is defined in a first image color space, typically a red, green, and blue (RGB) color space. The file image 74 is can be displayed on a client server monitor 78. When a user decides to send the image file to be printed, the user enters a print command to the client server 72 through an input device 80, such as a keyboard or mouse. The image file 74 is sent to a printer controller 86. The printer controller 86 can either be internal or external to a printer 90.

Typically, image files 74 sent from a client server 72 are Postscript™ or portable document format PDF™ files (standard formats of Adobe Systems, Inc., of San Jose, Ca.). Postscript™ files may contain a plurality of colorspaces. In office

enviornments, RGB files such as provided by MicrosoftWord and Powerpoint are most common, but in graphic arts, CMYK color spaces are common, as well. The image files 74 are typically defined within a first color space, which is commonly a red, green, and blue (RGB) color space. When the image files 74 are received by the printer controller 86, the printer controller 86 translates 64 the image files from the first color space format to a second color space format, which is then sent to a printer 90. The translation process is commonly referred to as raster image processing (Ripping), and typically translates the file from a RGB color space to a contone (CMYK) color space format that a printer 90 can use to controllably apply one or more toners 40 in varying quantities to halftone pixels 14 onto a substrate 16, to produce a printed image 12.

The printer controller 86 also produces a reduced resolution image file 50, of an image to be rendered by a printer 30. The reduced resolution thumbnail 50 can either be produced by the printer controller 86, or by the client server 72. The reduced resolution thumbnail 50 is usually produced to provide remote document viewing on a remote monitor 78.

The reduced resolution thumbnail 50 is typically defined in an RGB color space, while the print engine toners are typically defined in a CMYK color space. The toner usage estimation system 70 uses an algorithm to translate the RGB thumbnail bit map 50 into a set of estimated usage of C, M, Y, and K toner 40. The toner usage estimation system 70 shown in Figure 9 uses the reduced resolution bit map 50 provided by the print controller 86 to estimate the use of one or more toners to define an image 12 on a substrate 16. This analysis constitutes an algorithmic estimation of the amount of toner necessary to print a given page 12,16. The estimate of toner usage can be performed by either the printer controller 86 or the client server 72. When toner usage is performed on the client server 72, the printer controller 86 is available for other print related tasks.

Figure 10 is a block diagram of a toner usage estimation system 70a configured between a plurality of source computers 92a-m, a client server 72, and a plurality of printer controllers 86a-n and printers 90a-n. Reduced resolution bit maps 50 of one or more images are forwarded to the client server 72 from each of the printer controllers 86a-n. Toner usage estimation can be performed by the printer controllers 86a-n, by the client servers 72, or by the source computers 92a-m.

Figure 11 is a block diagram 94 of an alternate embodiment of the toner usage estimation system, wherein a client server 72 that includes accounting software 100 is located between a plurality of department servers 96a-m and a plurality of printer controllers 86a-n and printers 90a-n.

The print controllers 86a-n are adapted to provide reduced resolution bit maps 50 of one or more images 74. The department accounting software 100 tracks print jobs sent across the network 102, collects reduced resolution bit maps 50 from each job 84 sent to one or more printers 90a-n, and estimates the toner usage and printing cost of each printing job 84. One application for this embodiment is to track the actual or average cost of one or more print jobs 84 sent by each of the separate stations or departments 96a-n, and can therefore be used for departmental accounting (*e.g.* while one department 96 has a large number of jobs 84, the jobs are typically low in toner usage (low page cost); a second department 96 has a low number of jobs 84, but the jobs have a very high color toner usage (a high page cost)).

Although the toner usage estimation system and its methods of use are described herein in connection with client servers and printers, the system and techniques can be implemented with other computers and image processing devices, such as scanners and copiers, or any combination thereof, as desired.

Accordingly, although the invention has been described in detail with reference to a particular preferred embodiment, persons possessing ordinary skill in the art to which this invention pertains will appreciate that various modifications and enhancements may be made without departing from the spirit and scope of the claims that follow.

CLAIMS

What is claimed is:

1. A process, comprising the steps of:
receiving an image datastream bit map; and
estimating use of toner to define said image on a substrate, based upon said image datastream bit map.

2. The process of Claim 1, wherein said step of receiving said image datastream bit map includes counting a pixel datastream.

3. The process of Claim 1, wherein said step of estimating use of toner is performed on a client server.

4. The process of Claim 1, wherein said step of estimating use toner is performed on a printer controller.

5. The process of Claim 1, wherein said image datastream bit map is defined in a first image color space.

6. The process of Claim 5, wherein said first image color space is a RGB image color space.

7. The process of Claim 5, further comprising the step of:
translating said image datastream bit map defined in said first image color space to a second image color space; and wherein
said step of estimating use of said toner to define said image on said substrate is based upon said image datastream bit map defined in said second image color space.

8. The process of Claim 7, wherein said second image color space is a CMYK color space.

9. The process of Claim 7, wherein said step of estimating use of toner is performed on a client server.

10. The process of Claim 7, wherein said step of estimating use toner is performed on a printer controller.

11. A process, comprising the steps of:

receiving a reduced resolution bit map of an image residing in a first image color space;

translating said thumbnail preview bit map to a second image color space; and

estimating use of toner to define said image on a substrate based upon said translated reduced resolution bit map.

12. The process of Claim 11, wherein said first image color space is an RGB color space.

13. The process of Claim 11, wherein said second image color space is a contone color space.

14. The process of Claim 11, wherein said second image color space is a CMYK color space.

15. The process of Claim 11, wherein said step of estimating use toner is performed on a remote server.

16. The process of Claim 11, wherein said step of estimating use toner is performed on a printer controller.

17. The process of Claim 11, further comprising the step of:
providing an output signal containing said estimated use of toner to define said image.

18. The process of Claim 17, further comprising the step of:

sending said output signal to a client server.

19. The process of Claim 18, further comprising the step of:

determining cost of said defining said image on said substrate based on said sent output signal.

20. A toner usage estimation device, comprising:

a pixel coverage counter adapted to receive an image datastream bit map from a halftone screening circuit; and

a processor adapted to estimate use of toner to define an image on a substrate, based upon said image datastream bit map.

21. The toner usage estimation device of Claim 20, wherein said image datastream bit map is a halftone bit map.

22. A toner usage estimation device, comprising:

a computer adapted to receive a reduced resolution bit map of an image residing in a first image color space;

means for translating said reduced resolution bit map to a second image color space; and

an algorithm for estimating use of toner to define said image on a substrate, based upon said translated reduced resolution bit map.

23. The toner usage estimation device of Claim 22, wherein said first image color space is an RGB color space.

24. The toner usage estimation device of Claim 22, wherein said second image color space is a contone color space.

25. The toner usage estimation device of Claim 22, wherein said second image color space is a CMYK color space.

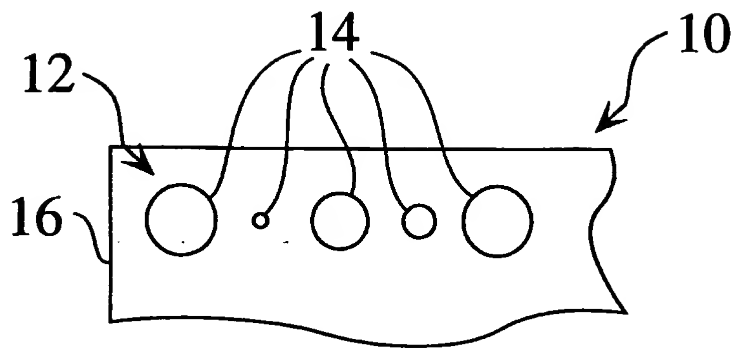


Fig. 1

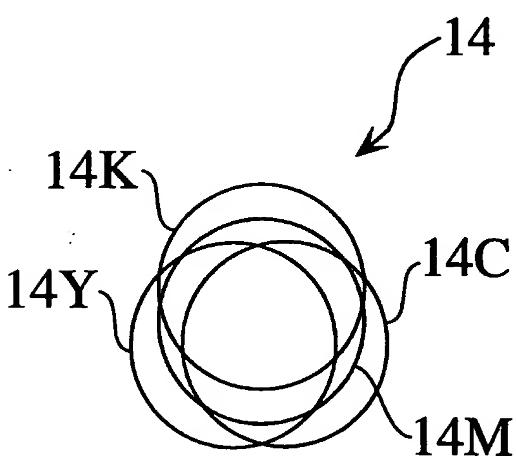


Fig. 2

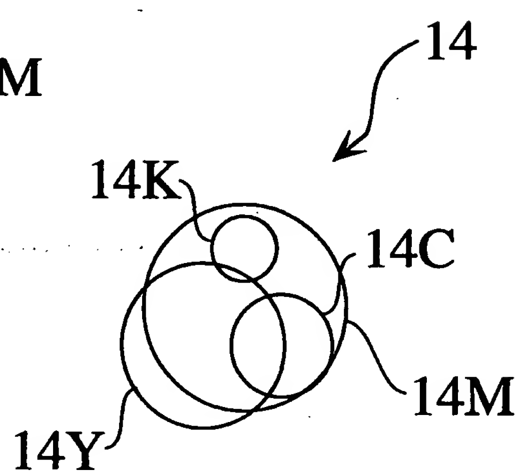
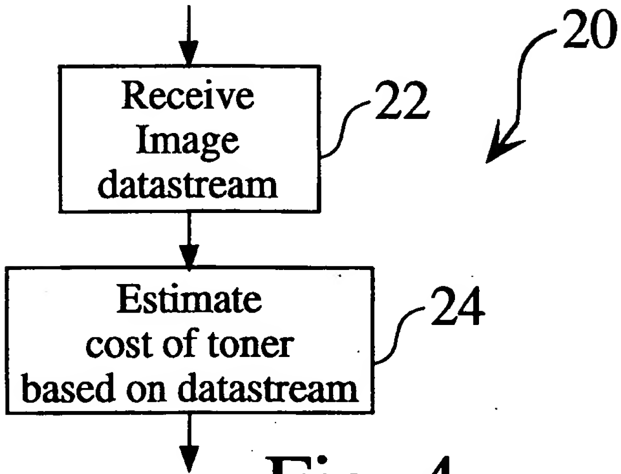
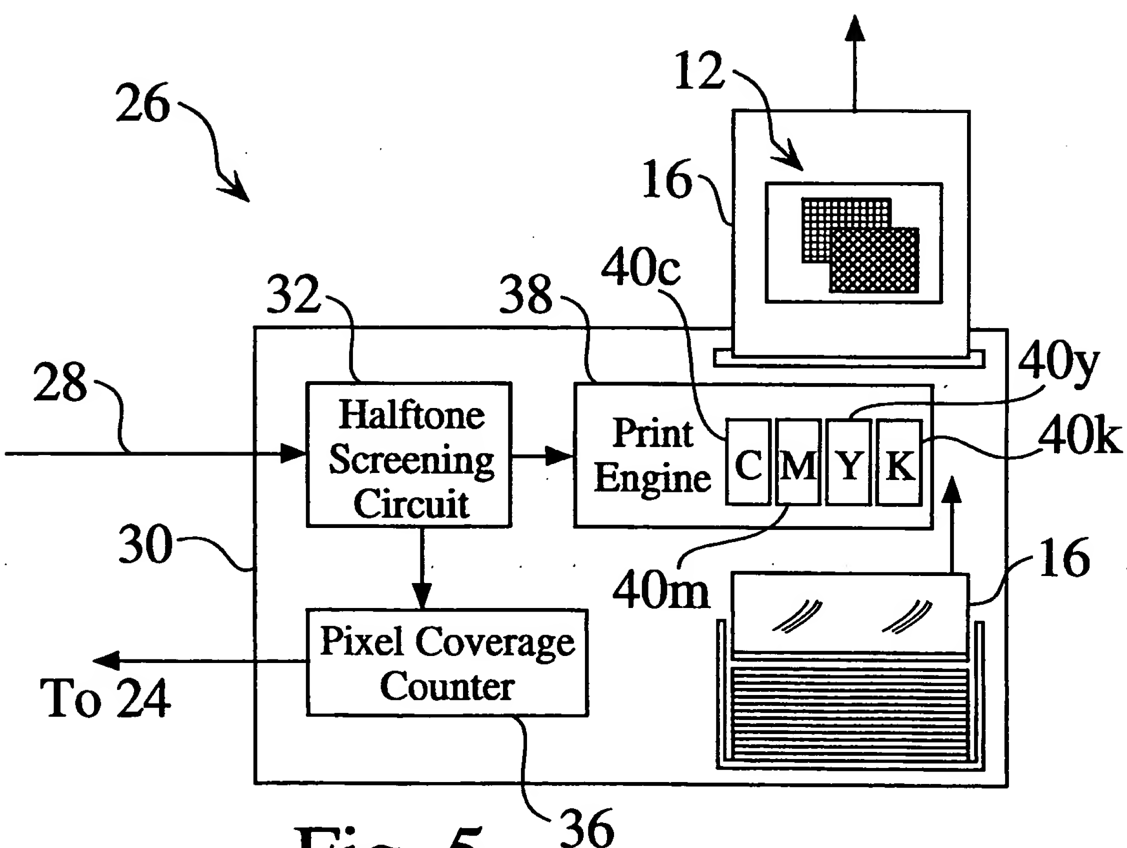


Fig. 3



20
Receive Image datastream
22
Estimate cost of toner based on datastream
24

Fig. 4



26
12
16
32
38
40c
40y
28
Halftone Screening Circuit
Print Engine
C
M
Y
K
40k
30
40m
16
Pixel Coverage Counter
To 24
36

Fig. 5

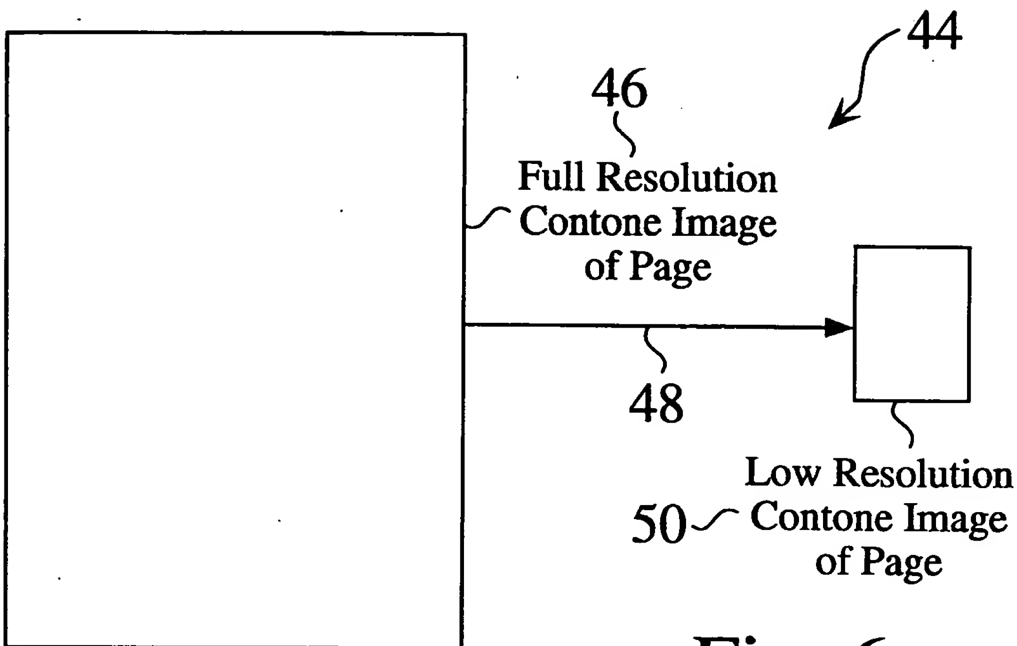

44
46
Full Resolution
Contone Image
of Page
48
Low Resolution
50 Contone Image
of Page

Fig. 6

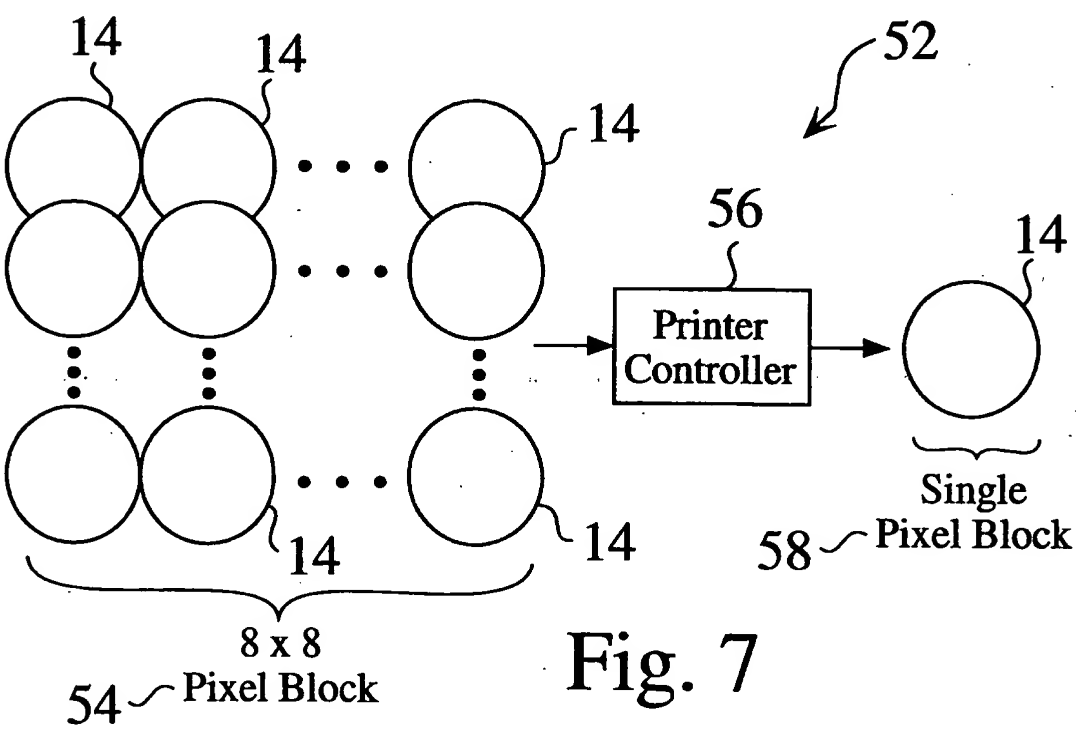

52
14
14
14
56
14
Printer
Controller
14
14
Single
58 Pixel Block
8 x 8
54 Pixel Block

Fig. 7

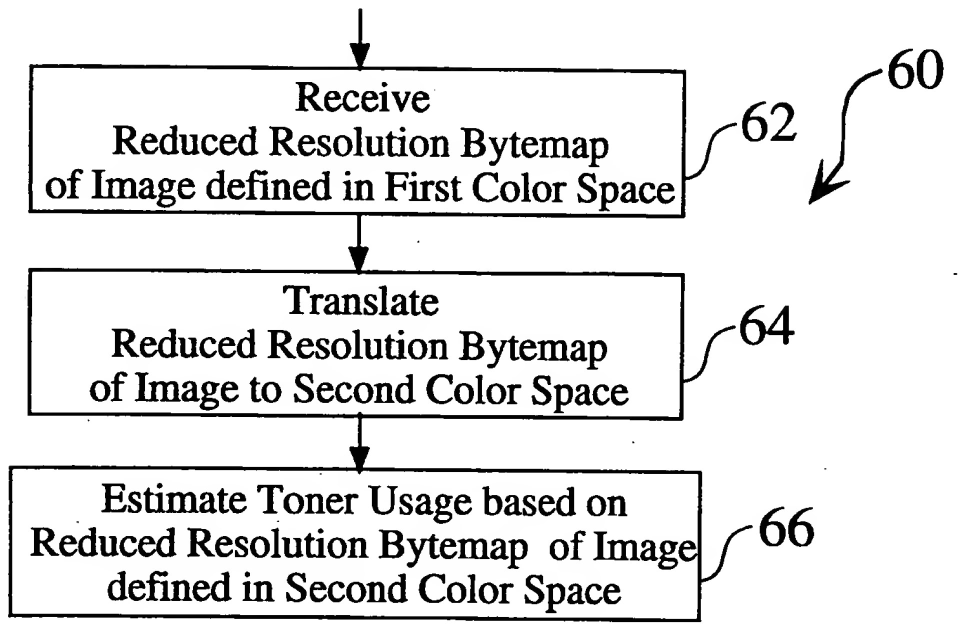
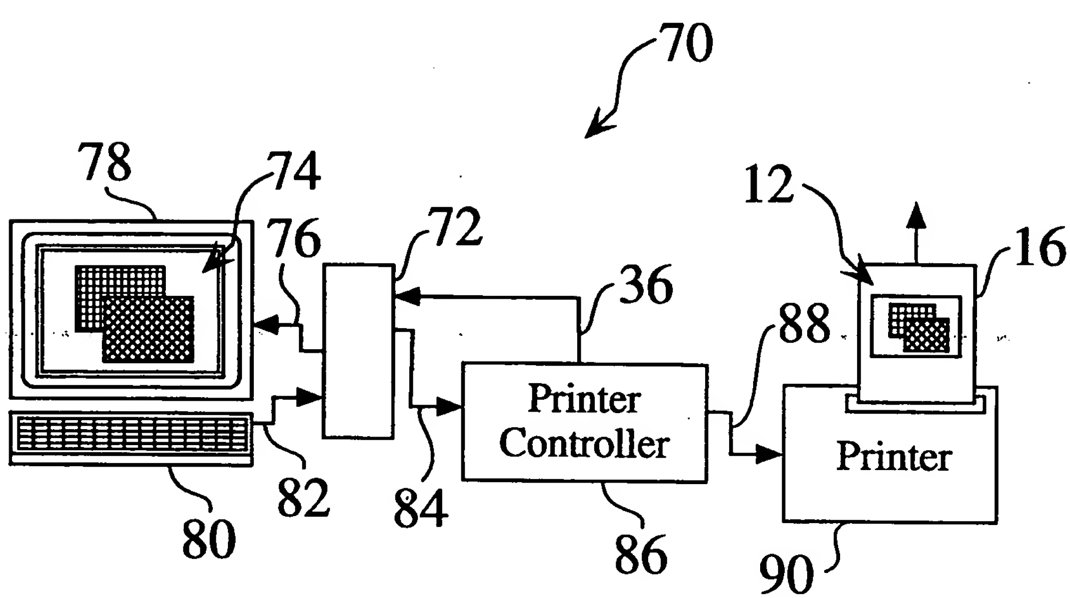

Receive
Reduced Resolution Bytemap
of Image defined in First Color Space
62
60
Translate
Reduced Resolution Bytemap
of Image to Second Color Space
64
Estimate Toner Usage based on
Reduced Resolution Bytemap of Image
defined in Second Color Space
66

Fig. 8


70
78
74
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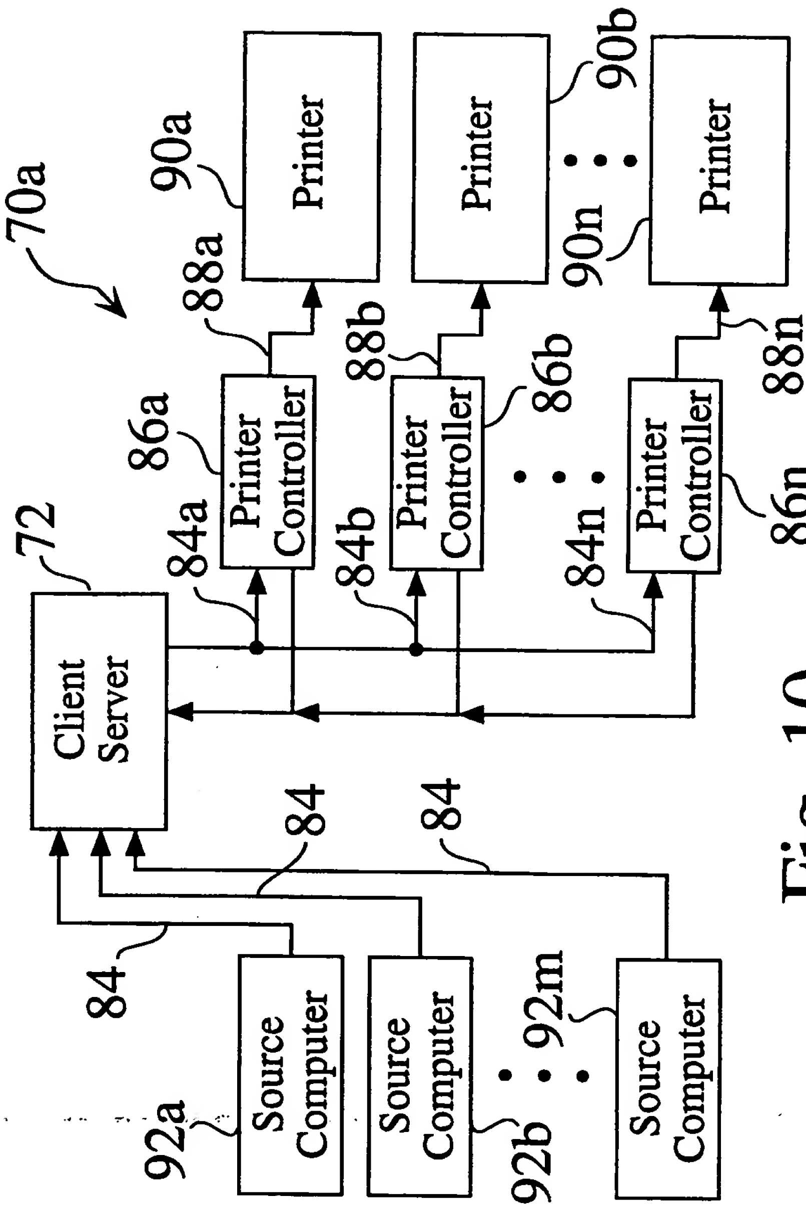
72
12
16
36
88
Printer
Controller
Printer
82
84
80
86
90

Fig. 9


70a
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84b
84n
Printer Controller
Printer Controller
Printer Controller
86a
86b
86n
88a
88b
88n
Printer
Printer
Printer
90a
90b
90n
84
84
84
84
Source Computer
Source Computer
Source Computer
92a
92b
92m

Fig. 10

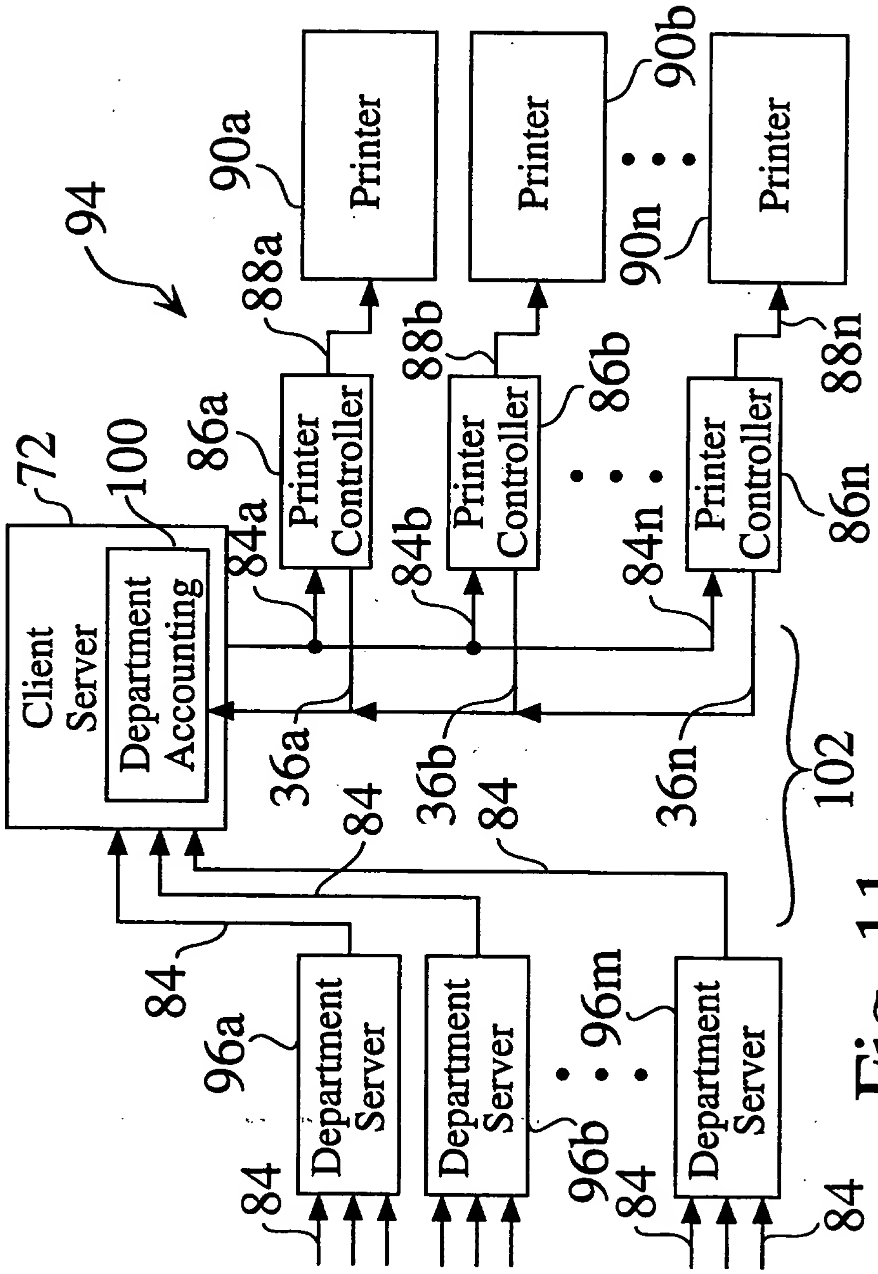
94
72
Client Server
100
Department Accounting
Printer Controller
Printer Controller
Printer Controller
Printer
Printer
Printer
Department Server
Department Server
Department Server
86a
86b
86n
88a
88b
88n
90a
90b
90n
84a
84b
84n
36a
36b
36n
84
96a
96b
96m
102

Fig. 11

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/25728

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G03G15/08 G03G21/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G03G H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	US 5 349 377 A (GILLILAND W KEITH ET AL) 20 September 1994 see abstract; claims; figures ---	1,2,20, 21 5-8 11, 15-19,22
Y A	US 5 604 578 A (SHIBUYA KUNIHIRO ET AL) 18 February 1997 see abstract; claims; figures ---	5-8 11-14, 22-25
A	US 5 592 298 A (CARUSO ANGELO T) 7 January 1997 see abstract; claims; figures ---	1,3,4, 9-11, 15-19
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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Int [illegible]ional Application No
PCT/US 98/25728

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
E	EP 0 893 909 A (SAMSUNG ELECTRONICS CO LTD) 27 January 1999 see claims; figures -----	1,2

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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

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06735577 SUPPLIER NUMBER: 14475090 (THIS IS THE FULL TEXT)
Color Printers: A Spectrum of Possibilities. (includes related articles on standard features, Editors' Choice awards, testing methodology and price comparisons) (Hardware Review) (evaluation of ten color thermal transfer and ink jet printers) (Evaluation)
Stone, M. David
PC Magazine, v12, n20, p233(16)
Nov 23, 1993
DOCUMENT TYPE: Evaluation
ISSN: 0888-8507
LANGUAGE: ENGLISH
RECORD TYPE: FULLTEXT; ABSTRACT
WORD COUNT: 3487
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ABSTRACT: Nine color thermal transfer printers, along with one color ink jet printer, are evaluated for price and performance. These printers, which have fallen dramatically in price during the past few years, include CalComp Inc's $8,995 ColorMaster Plus 6613XF, HP's $3,995 PaintJet XL300 PostScript and $2,399 DeskJet 1200C/PS, Eastman Kodak Co's $7,999 ColorEase PS, QMS Inc's $7,995 ColorScript 230 and $4,995 ColorScript 210, Seiko Instruments USA Inc's Professional ColorPoint PSH, and Tektronix Inc's $9,995 Phaser IIsdx, $3,695 Phaser 200e, and $5,995 Phaser 200i. PC Magazine has bestowed five Editors' Choice awards among this group, since each printer excels in a different area. The HP Deskjet 1200C/PS takes th honor for standalone or small workgroup business graphics, while Tektronix's Phaser 200e and 200i models win for larger workgroup graphics. For photo-realistic output, the award goes jointly to the Kodak ColorEase PS Printer and the Tektronix Phaser IIsdx.

TEXT:

Stratification among color printers is diminishing as output quality and prices improve for every technology. These ten thermal dye transfer, thermal wax transfer, and ink jet printers bring color closer to the mainstream.

Color printing has come of age. As recently as last year, high-quality color printers ranged from expensive to very expensive, with list prices of $4,995 and up. Even last year's worst color PostScript printer produced dramatically better output than the best color non-PostScript unit.

Over the past year, however, the depth and breadth of choices has increased dramatically, ranging from relatively inexpensive to expensive; from acceptable to dazzling color; from output suitable for business graphics to output ideal for photos; and from color only to color mixed with monochrome text.

Lower Prices Across the Board

List prices for this year's batch of color printers range from $1,699 to just under $10,000. Street prices dip well below $2,000--and even to $750 if you include the

Fargo Primera Color Printer--a Microsoft Windows Graphics Device Interface (GDI) printer that uses the same thermal dye transfer technology higher-priced models use.

Part of the price-range expansion comes from the introduction of ink jet technology into the high-end color market--specifically the $1,699 HP DeskJet 1200C and $2,399 HP DeskJet 1200C/PS, from Hewlett-Packard Co., and the somewhat more expensive HP PaintJet XL300 PostScript, at $3,995. The latter two are reviewed in this section. The HP PCL 5based DeskJet 1200C is identical to the DeskJet 1200C/PS in every way except for its lack of PostScript language support.

The market has also seen a 20 percent drop in price for thermal dye transfer (sometimes referred to as dye sublimation) and thermal wax transfer printers: Last year's list prices for thermal dye transfer printers were $9,995 to $11,900. Prices for the three thermal dye transfer printers reviewed this year--the Kodak ColorEase PS Printer, Seiko Instruments Professional ColorPoint PSH, and Tektronix Phaser IIsdx--range from $7,999 to $9,999. (Note that the marketing research firm BIS Strategic Decisions predicts comparable drops next year.)

Similarly, last year thermal wax transfer printers listed for $4,995 to $9,995. This year's list prices are $3,695 to $5,995 for the three letter-sizeonly thermal wax transfer printers reviewed--the QMS ColorScript 210, Tektronix Phaser 200e, and the Tektronix Phaser 200i. List prices are $7,995 to $8,995 for the two reviewed thermal wax transfer printers that can print on B-oversize paper--the QMS ColorScript 230 and the CalComp ColorMaster Plus 6613XF.

Review Criteria

To qualify for this category, a printer had to offer color output on at least letter-size (8.5- by 11-inch) paper and be priced over $1,000. (See the ink jet section for a review of the HP DeskJet 550C, a color ink jet that lists for $719 and sells for about $600.) Since most of our color printing tests are PostScript-based, we required that the printer offer PostScript Level 1, 2, or both. Finally, the printer had to ship by late August 1993.

In addition to the reviews of the printers mentioned above, you'll find sidebars here on two non-PostScript printers that we thought too interesting to ignore--the Kodak 450GL Digital Color Printer and the Fargo Primera Color Printer. The Kodak 450GL is a low-cost ($1,599) thermal dye transfer printer that outputs postcard-size images for photo ID badges and other niche uses. The Primera, priced at only $995, is a thermal wax transfer printer that uses the host PC's processor and memory to convert images into bitmaps that the printer can reproduce. By the time you read this, Fargo Electronics should be selling a kit for upgrading the Primera to thermal dye transfer.

Both are Windows printers, meaning that they come with drivers that work within Windows, and their low prices come mostly from their use of the PC as printer controller. They also use lower resolution than the 300 dots per inch that is standard for PostScript color printers.

One technology not represented here is solid ink--a variation on ink jet technology that melts solid ink instead of using liquid ink. The Tektronix Phaser III PXi, reviewed in last year's printer issue, uses this technology. There are two new solid ink printers that should be available by the time you read this. The $4,995 Jolt PSe, from Dataproducts Corp., was not shipping at the time of our testing. The $9,995 HS-1PS, from Brother International Corp., was shipping, but Brother was unable to

send us one in time for review. Unlike with the other color technologies, prices for solid ink printers have not changed since last year.

Seven other printers did not make it in time for testing or did not meet our criteria, but should be available by the time you read this. Three thermal wax transfer printers started shipping too late for inclusion in this overview: the General Parametrics Spectra*Star GT ($4,495), the Seiko Instruments ColorPoint PSN Model 4 ($5,999), and its counterpart, the B-size ColorPoint PSN Model 14 ($8,999).

Similarly, two thermal dye transfer printers were not shipping in time for our testing: the Shinko CHC-S746i ColorStream/DS Plus ($2,100), distributed by Mitsubishi International Corp., and the B-size Tektronix Phaser 480, priced at $14,995. The Codonics NP-600 Photographic Network Printer was shipping, but Codonics did not supply one for review.

Finally, one color PostScript ink jet printer, Lexmark's IBM Color Jetprinter PS 4079 ($3,199), met our criteria, but PC Magazine inadvertently did not review the product in time for publication. The IBM Color Jetprinter features 360-by-360 resolution, 144 color levels, and ColorGrade, a screening technique to produce quality halftones. Its score on our

Graphics Speed test was 0.4 graphics pages per minute, roughly halfway between the two other PostScript ink jet printers tested, the DeskJet 1200C/PS (0.6 gppm) and the PaintJet (0.2 gppm). We reviewed the IBM Color Jetprinter in the First Looks section of PC Magazine, January 26, 1993.

Revised Rules of Thumb

Lower prices and a wider price spread are the most obvious changes in high-end color printers since last year. But if you haven't looked at these printers lately, you'll have to unlearn some of what you may already know.

For example, since thermal dye transfer printers smooth colors to yield continuous-tone output, they've also been known to blur edges on thin lines and text, making them unsuitable for business graphics. But that problem is essentially gone this year, as manufacturers have new algorithms designed specifically to handle lines and text. You shouldn't have reservations (other than the over-$2.00 cost per image) about using them for business graphics as well as continuous-tone images.

Thermal wax transfer printers could always be counted on for fully saturated colors on transparencies. But business graphics on thick thermal paper stood out in a business report like heavy color plates in a book. Every thermal wax transfer printer in this year's batch, however, makes some attempt to print on more-or-less standard paper, ranging from copier paper to low-weight, uncoated thermal paper.

Ink jet printers have long had the opposite problem: While they produced good images on paper, they could not provide saturated colors on transparencies. The DeskJet 1200C/PS, however, prints transparencies that are within striking distance of thermal wax transfer for fully saturated colors, and are preferable in some ways, since the dithering patterns are less obvious.

Solid ink printers are still the only choice for printing on any media whatsoever that can make it through their paper paths. But solid ink, because of its continued high price, is still a second choice to the newly versatile ink jets.

Text and color

When you include low-end dot matrix and ink jet technologies, there are two kinds of color printers: those suitable for both color and black printing, and those that always use the slow color process, even when printing in black. Some such printers actually make black by combining cyan, magenta, and yellow.

Until this year, all high-end color printers fell into the second category. As a practical matter you simply wouldn't use them for standard monochrome printing.

The DeskJet 1200C and DeskJet 1200C/PS deserve special mention for breaking that mold. Not only do they use black ink when printing monochrome, but they print at rates you would expect from a standard monochrome printer--6 ppm on our tests. That makes the DeskJet 1200C and DeskJet 1200C/PS the first in a new breed: single printers that have both fast text speed and high-quality color output. We hope to see more like them in the future.

Shared Features

As you might expect, there are several issues that apply across the entire category. The most obvious is PostScript itself. Of ten PostScript printers covered here, six--HP's DeskJet 1200C/PS and PaintJet, Kodak's ColorEase, and Tektronix's Phaser 200e, 200i, and IIsdx--offer Adobe PostScript Level 2. The two QMS printers offer a proprietary QMS interpreter, with both Levels 1 and 2. The last two, Seiko's ColorPoint and CalComp's ColorMaster offer non-Adobe PostScript interpreters with Level 1 support only.

All other things being equal, Adobe PostScript is more desirable than a non-Adobe interpreter, and Level 2 is preferable to Level 1. But when choosing a printer, you should consider this issue only as a tiebreaker.

One last notable point is the easy setup of each of these printers. For thermal wax and thermal dye transfer printers, setup consists of installing the ribbon, loading the paper, and plugging the printer in. For ink jet printers, instead of installing the ribbon, you snap in four ink cartridges--one for each color. And remember that all of these color printers offer some level of network compatibility.

Finally, keep in mind that the most important issue in choosing a color printer is matching it to your output requirements. This year's batch of printers do a creditable job in a wider range than any before. But with four technologies to choose from, three of which are represented here, you should still pick whichever works best for your specific application.

Related Article

Highlights

Color Printers

COLOR PRINTERS have matured substantially in the past year, and their business appeal is greater than ever. Prices have fallen dramatically even as output quality and speed have improved. Market segmentation is disappearing, leaving a spectrum of choices ranging in price from under $2,000 to nearly $10,000.

INK JET PRINTERS have offered passable color in the past, but they couldn't compete with more expensive color technologies. This year, the impressive HP DeskJet 1200C/PS shatters the stereotype, offering striking color output, speedy performance, and true Adobe PostScript Level 2 support for about $2,000.

BETTER TEXT OUTPUT is a strength of this year's color printers. Even thermal dye transfer printers--historically weak for fine detail--show improvement. The DeskJet 1200C/PS ink jet printer, which unlike most color printers also prints in true (not process) black, produces crystal-clear black text with the 6-page-per-minute speed of a good laser printer.

THERMAL DYE TRANSFER still produces the best photo-realistic images, but it remains expensive. Thermal wax transfer and ink jet printers both excel at business graphics, with ink jets edging ahead for mixed text and graphics and thermal wax transfer units leading for network use. Solid-ink printers are adept at handling unusual paper stock, but no new models were available for us to review. Dataproducts will be shipping a new solid ink printer, the Jolt PSe, by the time you read this.

TABLOID-SIZE COLOR PRINTING is possible with three of the ten reviewed models--the CalComp ColorMaster Plus 6613XF and QMS ColorScript 230 thermal wax transfer units, and the HP PaintJet XL300 PostScript ink jet printer. Tektronix has just announced its Tektronix Phaser 480, the first PC-compatible B-size thermal dye transfer printer (shipping next year). Be prepared to pay for the extra size: B-size printers cost about twice as much as comparable letter-size models.

Related Article

Editors' Choice

* For business graphics--standalone or small workgroupHP DeskJet 1200C/PS
* For business graphics--workgroupTektronix Phaser 200e Tektronix Phaser 200i
* For photo-realistic outputKodak ColorEase PS Printer Tektronix Phaser IIsdx

With the diverse applications for which color output is used, it didn't make sense to select only one or two products for Editors' Choice recognition. Instead, we've chosen five printers, all exceptional in their respective fields. For truly photo-realistic output--still the province of thermal dye transfer printers--past leader Tektronix offers the Tektronix Phaser IIsdx. Eastman Kodak Co., a newcomer to PC-based color printing, brings the Kodak ColorEase PS Printer.

When it comes to business graphics, the forte of thermal wax transfer printers, the Tektronix Phaser 200e and Tektronix Phaser 200i excel. But ink jet mogul Hewlett-Packard Co. threatens the Tektronix hegemony: The $2,399 HP DeskJet 1200C/PS offers even better output and blazing text speed at a far lower price. Only the DeskJet 1200C/PS's lack of networking conveniences kept it from completely outclassing the thermal wax transfer models.

MAINSTREAM CHOICES

The DeskJet 1200C/PS offers a previously unheard-of set of features: superb color and monochrome output, high performance, and a manageable price. It produces striking color output even on transparencies, typically a weak point for ink jet printers. It prints monochrome text at 6 pages per minute and with resolutions as high as 600 by 300 dots per inch. At a street price of around $2,000 with a true Adobe PostScript Level 2 interpreter, it's an unbeatable bargain. (A non-PostScript version, the HP DeskJet 1200C, is available for $1,699 list (about $1,299 on the street). We recommend this model for cost-conscious buyers.

The DeskJet 1200C/PS's only significant shortcoming is its limited networking savvy. It won't tell you when it's used up one color of ink, so it requires close monitoring. And as it doesn't support a second tray, you have to reload manually to switch between transparencies and paper.

If you want a printer that can produce colorful business graphics and is more network-friendly, the Phaser 200e ($3,695) and Phaser 200i ($5,995) thermal wax transfer printers are excellent choices. Both offer outstanding output quality (though not as impressive as that of the DeskJet 1200C/PS). The Phaser 200e is the least expensive thermal wax transfer printer we've seen. But the Phaser 200i is the fastest thermal wax transfer printer we've ever tested.

THERMAL DYE TRANSFER

If you need photo-realistic output, choosing between the $7,999 ColorEase and the $9,995 Phaser IIsdx could be difficult. Both generate superb output--significantly better than the Phaser IIsd, an Editors' Choice last year. The ColorEase did a slightly better job rendering flesh tones--not surprising, given Kodak's background in photography--while the Phaser IIsdx yielded marginally better detail in dark areas.

The ColorEase costs substantially less than the Phaser IIsdx, but the Phaser IIsdx was in some cases twice as fast--a difference that adds up quickly if you need to produce multiple proofs.

HONORABLE MENTIONS

Two of the color printers we tested fall slightly short in output quality but offer unique capabilities that merit honorable mention. For producing business graphics on B-size media, the CalComp ColorMaster Plus 6613XF ($8,995) is a solid choice. For thermal dye transfer, B-size printing isn't yet a reality on the PC platform (although Tektronix has announced a B-size full-bleed printer, the Tektronix Phaser 480, shipping next year). The closest right now is the Seiko Instruments Professional ColorPoint PSH ($9,999), which prints on B4-size (10.2- by 14.3-inch) stock and can produce full-bleed letter-size pages. Its output quality is good, though a step below that of the Phaser IIsdx and ColorEase.

Related Article

Benchmark Tests: Color Printers

The CalComp ColorMaster Plus 6613XF scored an impressive 2.0 graphics pages per minute on our Graphics Speed test, but it fell behind the Tektronix Phaser 200i and Tektronix Phaser 200e on our Microsoft Windows applications tests. The HP DeskJet 1200C/PS outpaced the HP PaintJet XL300 PostScript by a substantial margin.

How We Tested

Using the parallel port, we performed each speed test in PostScript mode.

The Power Consumption test measures the printer's energy usage under two conditions: when printing and when idle. For this test only, lower scores indicate better results.

The Graphics Speed test measures the printer's speed in producing two copies of a complex single-page graphic containing a TIFF image, horizontal and vertical gray scales, horizontal color scales, and line art.

The Lotus 1-2-3 for Windows test measures the printer's speed in producing a complex two-page spreadsheet that has color pie, bar, and line charts. We tested each printer with the Windows driver recommended by the printer's manufacturer.

The CorelDRAW test measures the printer's speed in producing a single-page CorelDRAW graphic that contains a TIFF image, horizontal and vertical gray scales, and line art. We tested each printer with the Microsoft Windows driver recommended by the printer's manufacturer.

The HP DeskJet 1200/PS and Kodak ColorEase PS Printer produced unexpectedly strong and deep blues--typically difficult for color printers because of ink and dye limitations.

Process black for most printers was nearly perfect, though the CalComp ColorMaster Plus 6613 and both QMS printers tended slightly toward blue, and the Tektronix Phaser 200e and Phaser 200i leaned toward green.

How We Tested

To determine each printer's range and purity of color, we printed a sample containing the primary CYM colors (cyan, yellow, and magenta), secondary RGB colors (red, green, and *blue*), and process and pure *black* (K). Pure black is available only on those printers that support four-pass ribbons or, in the case of ink jets, four colors of ink.

Using a Gretag SPM 50 spectrophotometer, we took color readings of the various output samples under fluorescent light, with the sample page placed over a white foam board to minimize the effects of paper translucence. Before we began each reading, the Gretag SPM 50 was calibrated to the paper on which the sample was printed, since each manufacturer supplies its own paper for its printers.

What It Means

The CIE (Commission Internationale de L'Eclairage) L.a.b. color space is a three-dimensional representation of color, including lightness. The circles of hues shown below are a slice of the CIE color space with the brightness component omitted.

Using the results from the spectrophotometer, we superimposed our measurements of each sample color on the slice of color space. The position of the CYM, RGB, and K samples for each printer shows how it interprets each color.

For printers that were able to produce both process and pure black, we have indicated the results for both. Ideally, process and pure black should be close to indistinguishable.

Related Article

Price Comparison: A Look at Per-Page Costs

In this chart we list total printing costs per page for the ten reviewed color printers. Because the cost of special paper required by most color printers is considerable, we have included it in these calculations. In cases where a printer uses standard photocopier paper, we have assumed a cost of 1 cent per sheet.

For ink jet printers, the cost per page varies depending on the amount of *ink* *coverage*; here we *estimate* *cost* at 25 percent and 100 percent coverage using figures provided by Hewlett-Packard Co. For other technologies represented here, cost per page is constant regardless of *color* *coverage*.

		Cost per page Paper	Transparency
LETTER-SIZE OUTPUT			
CalComp ColorMaster Plus 6613XF	Three-color ribbon	$0.60	$1.39
	Four-color ribbon	$0.64	$1.43
Eastman Kodak ColorEase PS Printer	Three-color ribbon	$2.10	$2.60
HP DeskJet 1200C/PS	25 percent	$0.13	$1.32
	100 percent *ink* *coverage*	$0.50	$1.69
HP PaintJet XL300 PostScript	25 percent *ink* *coverage*	$0.40	$1.59
	100 percent *ink* *coverage*	$1.57	$2.76
QMS ColorScript 210	Three-*color* ribbon	$0.57	$1.54
	Four-color ribbon	$0.63	$1.60
QMS ColorScript 230	Four-color ribbon	$0.68	$1.65
Seiko Instruments Professional	Three-color ribbon	$2.50	$3.90
ColorPoint PSH	Four-color ribbon	$4.50	$5.90
Tektronix Phaser 200e	Three-color ribbon	$0.56	$1.60
	Three-color ribbon with plain-paper coat	$0.60	$1.71
Tektronix Phaser 200i	Three-color ribbon	$0.56	$1.60
	Three-color ribbon with plain-paper coat	$0.60	$1.71
Tektronix Phaser Iisdx	Three-color ribbon	$2.25	$3.25
	Four-color ribbon	$2.75	$3.75
B-SIZE OUTPUT			
CalComp ColorMaster Plus 6613XF	Three-color ribbon	$0.65	$2.09
	Four-color ribbon	$0.69	$2.13
HP PaintJet XL300 PostScript	25 percent *ink* *coverage*	$0.80	N/A
	100 percent *ink* *coverage*	$3.14	N/A
QMS ColorScript 230	Four-*color* ribbon	$0.74	$1.85